The documentation and process conversion measures necessary to comply with this revision shall be completed by 4 November 1999.

INCH-POUND

MIL-PRF-19500/301D
4 August 1999
SUPERSEDING
MIL-S-19500/301C
15 March 1993

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN SILICON, LOW-POWER
TYPE 2N918
JAN, JANTX, JANTXV AND JANS,

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for NPN, silicon, ultra-high frequency transistors. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (similar to TO – 72).

1.3 Maximum ratings.

Types	P_T 1/ T_A = +25°C	P_T 2/ T_C = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{STG} and T_J
	mW	mW	V dc	V dc	V dc	mA dc	°C
2N918	200	300	30	15	3.0	50	-65 to +200

1/ Derate linearly, 1.14 mW/°C for T_A > +25°C.
2/ Derate linearly, 1.71 mW/°C for T_C > +25°C.

1.4 Primary electrical characteristics at T_A = +25°C.

Limit	$\|h_{FE}\|$ V_{CE} = 10 V dc I_C = 4 mA dc f = 100 MHz	$r_{b'}$ C_c V_{CB} = 10 V dc I_E = -4.0 mA dc f = 79.8 MHz	C_{obo2} V_{CB} = 10 V dc I_E = 0 mA dc 100 kHz ≤f≤1 MHz	NF V_{CE} = 6 V dc I_C = 1 mA dc f = 60 MHz g_s = 2.5 mmho	G_{pe} V_{CB} = 12 V dc I_C = 6.0 mA dc f = 200 MHz
		ps	pF	dB	dB
Minimum	6.0				15
Maximum	18.0	25	1.7	6.0	

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad St., Columbus, OH 43216-5000, by using the addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.4 Primary electrical characteristics at T_A = +25°C - Continued.

Limit	h_{FE1} V_{CE} = 10 V dc I_C = 500 µA dc	h_{FE2} V_{CE} = 1.0 V dc I_C = 3.0 mA dc	h_{FE3} V_{CB} = 10 V dc I_C = 10 mA dc
Minimum	10	20	20
Maximum		200	

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 and 4 of this specification, whether or not they are listed.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service, Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-PRF-19500 and as follows:

g_S ..... Noise source conductance.

P_O ..... Oscillator, power output.

R_{BE} ..... External resistance, base to emitter.

3.3 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (similar to TO-72) herein.

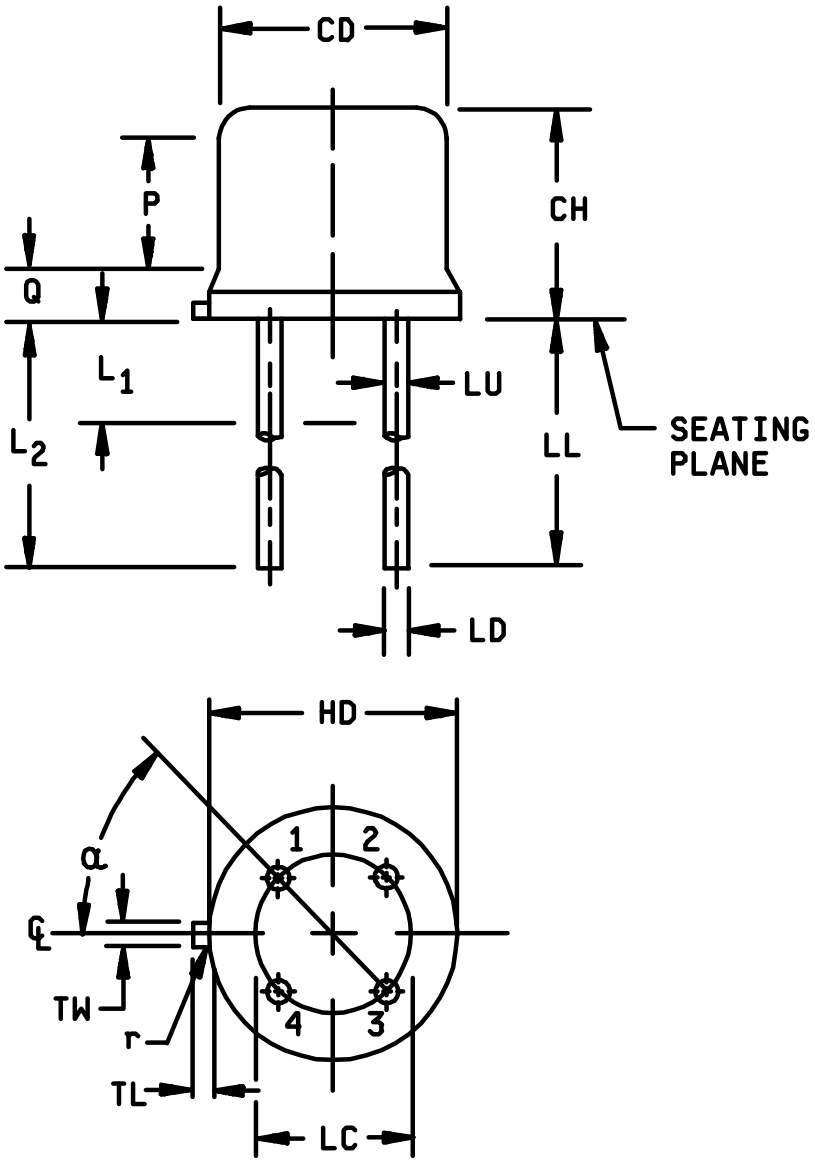


FIGURE 1. Physical dimensions, (similar to T0-72).

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	0.178	0.195	4.52	4.95	
CH	0.170	0210	4.32	5.33	
HD	0.209	0.230	5.31	5.84	
LC	0.100 TP		2.54 TP		
LD	0.016	0.021	0.41	0.53	2,5
LL	0.500	0.750	12.70	19.05	5
LU	0.016	0.019	0.41	0.48	3,5
L_1		0.050		1.27	
L_2	0.250		6.35		
TL	0.028	0.048	0.71	1.22	7
TW	0.036	0046	0.91	1.17	
P	0100		2.54		
Q		0.040		1.02	
r		0.007		0.18	
α	450 TP				

NOTES:
1. Metric equivalents are given for general information only and are based upon 1 inch = 25.4 mm.
2. Measured in the zone beyond 0.250 (6.35 mm) from the seating plane.
3. Measured in the zone 0.050 (1.27 mm) and 0.250 (6.35 mm) from the seating plane.
4. The active elements are electrically insulated from the case.
5. All 4 leads.
6. Lead 1 is the emitter, lead 2 is the base, lead 3 is the collector, and lead 4 is the case.
7. Symbol TL is measured from HD maximum.

FIGURE 1. Physical dimensions, (similar to T0-72) continued.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500. Where a choice of lead finish is desired, it shall be specified in the contract or purchase order (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups in table I herein.

3.7 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified manufacturer's list before contract award (see 4.2 and 6.3).

4.VERIFICATION

4.1 Classification of Inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3)

c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 Screening. Screening shall be in accordance with table IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
9	I_{CBO1} and h_{FE2}	
11	I_{CBO1} and h_{FE2} ΔI_{CBO1} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE2} = ±15 percent.	I_{CBO1} and h_{FE2}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{CBO1} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE2} = ±15 percent.	Subgroup 2 of table I herein; ΔI_{CBO1} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE2} = ±20 percent.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

2N918.....V_{CB} = 10 V dc, P_T = 200 mW at T_A = room ambient as defined in the general requirements of paragraph 4.5 in MIL-STD-750.

NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. Group A inspection shall be performed on each sublot.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500 and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIa (JANS) and table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and paragraphs 4.4.2.1 and 4.4.2.2 herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

4.4.2.1 Group B inspection, table VIa (JANS) of MIL-PRF-19500.

a. Subgroup 3, condition for bond strength is test condition A. All internal leads for each device shall be pulled separately.

b. Subgroup 4, condition for intermittent operation life are as follows: V_{CB} = 10 V dc; P_T = 200 mW at T_A = room ambient as defined in the general requirements of MIL-STD-750, 4.5; $t_{on} = t_{off}$ = 3 minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.

c. Subgroup 5, condition for steady-state operation life (accelerated) are as follows: V_{CB} = 10 V dc; T_A = 125°C ± 25°C for 96 hours, P_T = 200 mW at T_A = 100°C or adjusted as required according to the chosen T_A to give an average T_J = 275°C.

4.4.2.2 Group B inspection, table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500.

a. Subgroup 3, method 1027, conditions for steady-state operation life are as follows: V_{CB} = 10 V dc; adjust P_T to achieve T_J = 150°C minimum. T_A = room ambient as defined in the general requirements of paragraph 4.5 in MIL-STD-750. No heat sink or forced-air cooling on devices shall be permitted.

b. Subgroup 3, condition for bond strength is test condition A. All internal leads for each device shall be pulled separately.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF- and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

4.4.3.1 Group C inspection, table VII of MIL-PRF-19500.

a. Subgroup 2, condition for terminal strength is test condition E.

b. Subgroup 6, method 1027, conditions for Steady-state operation life (accelerated) are as follows: V_{CB} = 10 V dc, adjust P_T to achieve T_J = 150°C minimum. T_A = room ambient as defined in the general requirements of MIL-STD-750, (see 4.5). No heat sink or forced air cooling on the devices shall be permitted.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Input capacitance. This test shall be conducted in accordance with method 3240 of MIL-STD-750 except that the output capacitor shall be omitted.

4.5.2 Disposition of case lead during electrical measurements. All electrical measurements and operating life test shall be performed with the case lead connected to the source.

4.5.3 Noise figure. The noise figure shall be measured using commercially available test equipment and its associated standard test procedures (see figure 2).

4.5.4 Collector-base time constant. This parameter may be determined by applying an rf signal voltage of 1.0 volt (rms) across the collector-base terminals, and measuring the ac voltage drop (V_{eb}) with a high-impedance rf voltmeter across the emitter-base terminals. With f = 79.8 MHz used for the 1.0 volt signal, the following computation applies:

$r_{b'} C_c$: (psec) = 2 x V_{eb} (millivolts)

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage, collector to base	3001	Bias Condition D, I_C = 1.0 µA dc	$V_{(BR)CBO}$	30		V dc
Breakdown voltage, collector to emitter	3011	Bias Condition D, I_C = 3.0 mA dc	$V_{(BR)CEO}$	15		V dc
Breakdown voltage, emitter to base	3026	Bias Condition D, I_E = 10 µA dc	$V_{(BR)EBO}$	3		V dc
Collector to base cutoff current	3036	Bias Condition D, V_{CB} = 25 V dc	I_{CBO1}		10	nA dc
Emitter to base cutoff current	3061	Bias Condition D, V_{EB} = 2.5 V dc	I_{EBO}		10	nA dc
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 500 µA dc;	h_{FE1}	10		
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 3.0 mA dc;	h_{FE2}	20	200	
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 10 mA dc;	h_{FE3}	20		
Collector to emitter voltage (saturated)	3071	I_C = 10 mA dc; I_B = 1.0 mA dc;	$V_{CE(sat)}$		0.4	V dc
Base to emitter voltage (saturated)	3066	Test condition A; I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{BE(sat)}$		1.0	V dc
Subgroup 3						
High temperature operation		T_A = +150°C				
Collector to base cutoff current	3036	Bias Condition D, V_{CB} = 25 V dc	I_{CBO2}		1.0	µA dc
Low-temperature operation		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 3.0 mA dc	h_{FE4}	10		

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4						
Open circuit output capacitance	3236	V_{CB} = 0 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo1}		3.0	pF
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo2}		1.7	pF
Input capacitance (output open- circuited)	3240	V_{EB} = 0.5 V dc; I_C = 0; 100 kHz ≤ f ≤ 1 MHz	C_{ibo}		2.0	pF
Magnitude of common emitter, small- signal short-circuit forward current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 4.0 mA dc; f = 100 MHz	$\|h_{FE}\|$	6.0	18	
Noise figure		V_{CE} = 6 V dc; I_C = 1.0 mA dc; f = 60 MHz; g_s = 2.5 mmho (see 4.5.2, 4.5.3, and figure 2)	NF		6.0	dB
Small-signal power gain	3256	V_{CB} = 12 V dc; I_C = 6.0 mA dc; f = 200 MHz; (see 4.5.2 and figure 3)	G_{pe}	15		dB
Collector-base time constant		V_{CB} = 10 V dc; I_E = -4.0 mA dc; f = 79.8 MHz (see 4.5.2 and 4.5.4)	$r_{b'} C_c$		25	ps
Oscillator power output		V_{CB} = 15 V dc; I_C = 8.0 mA dc; f ≥ 500 MHz (see figure 4)	P_o		30	mW
Collector efficiency		V_{CB} = 15 V dc; I_C = 8.0 mA dc; f ≥ 500 MHz (see figure 4)	η		25	%
Subgroup 5						
Not applicable						

1/ For sampling plans, see MIL-PRF-19500.

TABLE II. Groups B and C delta electrical measurements. 1/ 2/ 3/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector-base cutoff current	3036	Bias condition D; V_{CB} = 25 V dc	ΔI_{CBO1} 4/	100 percent of initial value or 5 nA dc, whichever is greater.		
2.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 3.0 mA dc	Δh_{FE2} 4/	± 25 percent change from initial reading		
3.	Collector-emitter voltage (saturated)	3071	I_C = 10 mA dc; I_B = 1.0 mA dc	$\Delta V_{CE(sat)}$ 4/	± 50 mV dc change from previously measured value.		

1/ The delta electrical measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:

a. Subgroup 4, see table II herein, step 3.
b. Subgroup 5, see table II herein, steps 1, 2 and 3.

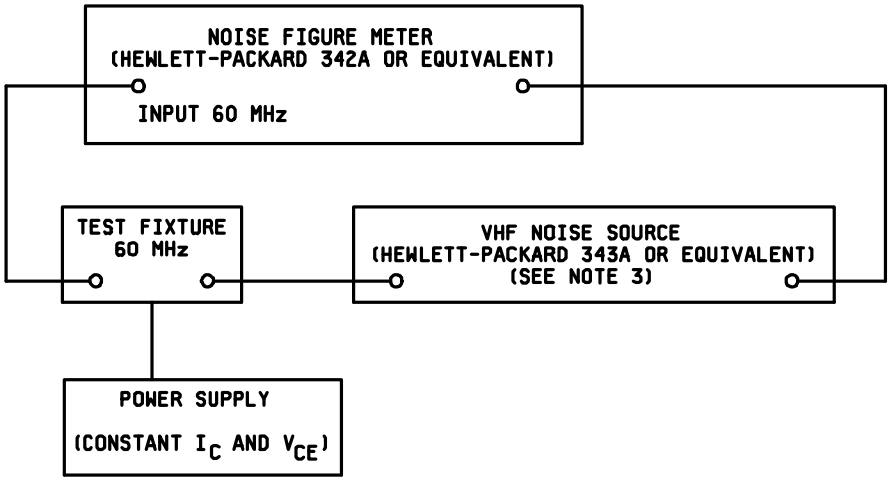
2/ The delta electrical measurements for table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500 are as follows:

a. Subgroups 3 and 6, see table II herein, step 2.

3/ The delta electrical measurements for table VII of MIL-PRF-19500 are as follows:

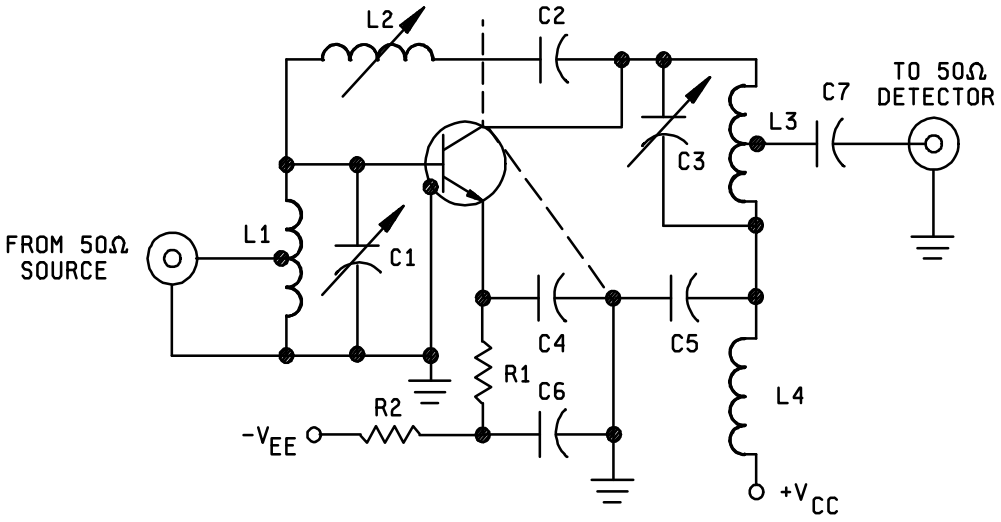
a. Subgroup 6, see table II herein, steps 1, 2 and 3 for JANS level and step 2 for JAN, JANTX, and JANTXV levels.

4/ Devices which exceed the group A limits for this test shall not be acceptable.



NOTES:
1. The test fixture shall consist of a 60 MHz tuned amplifier and suitable biasing circuits. It should be constructed utilizing very high-frequency design techniques.
2. The effective source susceptance should be tuned for each device being tested to obtain minimum noise figure.
3. The HP-343A has a 50-ohm output resistance, therefore a suitable impedance transformer must be used to obtain an effective source conductance of 2.5 mmho at the transistor with minimum losses.

FIGURE 2. Block diagram for noise-figure test.



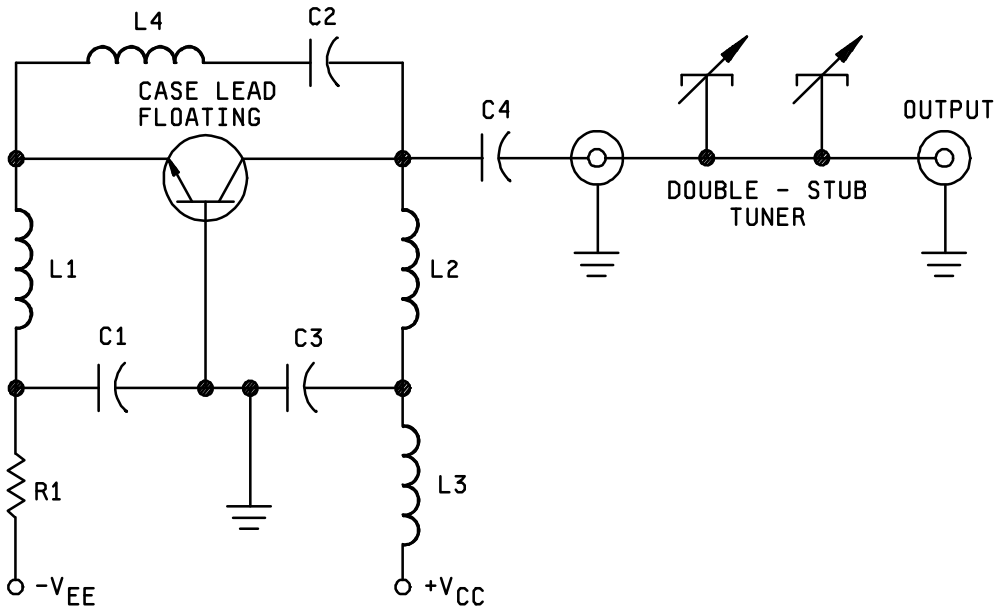
NEUTRALIZATION PROCEDURE:

a. Connect a 200 MHz signal generator (with a 50 ohm output impedance) to the input terminals of the amplifier, and connect a 50 ohm rf voltmeter to the output terminals of the amplifier.
b. Apply V_{EE} and V_{CC} to obtain the specified test conditions.
c. Adjust the output of the signal generator to approximately 10 millivolts and tune C_1 and C_3 for maximum output.
d. Interchange the connections to the signal generator and rf voltmeter and with sufficient signal applied at the output terminals, tune L_2 for a minimum indication on the rf voltmeter.
e. Repeat this sequence until optimum settings are obtained for all variables.

CIRCUIT-COMPONENT INFORMATION:

C1:	3-12 pF
C2 and C7:	1000 pF
C3:	1.5 - 7.5 pF
C4 and C5:	0.01 µF
C6:	0.05 µF
L1:	3½ T No. 16 AWG 5/16" ID, 7/16" length, Turns ratio ≅ 2 to 1
L2:	0.4 - 0.65 µh, Miller No. 4303 (or equal)
L3:	8 T No. 16 AWG, 1/8" ID, 7/8" length, Turns ratio ≅ 8 to 1
L4:	200 MHz RFC
R1:	100Ω
R2:	1 kΩ

FIGURE 3. Small-signal power gain.



OSCILLATOR ADJUSTMENT PROCEDURE:

Measurement of P_o shall be made in this circuit or a suitable equivalent. The circuit adjustment procedure is as follows:

a. Set V_{CC} and V_{EE} to obtain the specified test conditions.
b. Adjust the stub tuner to obtain the maximum output at the specified frequency of oscillation.
c. Check I_C and reset if necessary.
d. Read P_o.

Note 1. Collector efficiency (η), may be determined as follows:

$$\eta \text{ in } \% \frac{P_o}{120} \times 100$$ Where P_o is in milliwatts

CIRCUIT-COMPONENT INFORMATION:

C1 and C3:	1000 pF
C2:	50 pF
C4:	75 pF
R1:	2.2 kΩ
L1 and L3:	500 mC RFC
L2:	2 turns No. 16 AWG, 3/8" OD, 1¼" length
L4:	9 turns No. 22 AWG, 3/16" OD, ½" length

Double-stub tuner consists of the following commercially available components:

2 GR Type 874 TEE (or equivalent)
1 GR Type 874-D20 Adjustable Stub (or equivalent)
1 GR Type 874-LA Adjustable Line (or equivalent)
1 GR Type 874-WN3 Short-Circuit Termination (or equivalent)

FIGURE 4. Oscillator power output.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements should be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Issue of DODISS to be cited in the solicitation (see 2.1.1).

b. The lead finish as specified (see 3.3.1).

c. Type designation and quality assurance level.

d. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturer's List QML-19500 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, DSCC-VQE, Columbus, OH 43216.

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:
Army - CR
Navy - EC
Air Force - 11
NASA – NA
DLA - CC

Review activities:
Army - AR, MI
Navy - AS, CG, MC, SH
Air Force - 19, 99

Preparing activity:
DLA - CC

(Project 5961-2136)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of Requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-PRF-19500/301D	**2. DOCUMENT DATE (YYMMDD)** 990804

3. DOCUMENT TITLE
SEMICONDUCTOR DEVICE, TRANSISTOR, NPN SILICON, LOW-POWER TYPE 2N918 JAN, JANTX, JANTXV AND JANS,

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) Commercial DSN FAX EMAIL	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. Point of contact: Alan Barone,	b. TELEPHONE Commercial 614-692-0510 DSN 850-0510 FAX 614-692-6939 EMAIL alan_barone@dscc.dla.mil
c. ADDRESS : Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad Street, Columbus, OH 43216-5000	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-68880